INDEX.

ALGEBRA (See Solutions and Problems).
ARITHMETIC (See Solutions and Problems).
BIOGRAPHIES (With Portraits)—
Cayley, Arthur, by Alexander Macfarlane..... 99-102
Cayley, Arthur, by George Bruce Halsted..... 102-106
Chauvenet, Professor William, by F. P. Matz..... 33-37
Lambert, John Henry, by George Bruce Halsted..... 209-211
Lobachevsky, by George Bruce Halsted..... 137-139
Macfarlane, Alexander, M. A., D. Sc., LL. D., by J. M. Colaw. 1-4
Peirce, Benjamin, by F. P. Matz..... 173-179
Stone, Ormond, by F. P. Matz..... 299-301
Tchebychey, Pafnutij Lvovitsch, by George Bruce Halsted..... 61-63
Wood, Professor De Volson, by F. P. Matz..... 253-256
Wood, Hudson A., by F. P. Matz..... 343-345
BOOKS, Reviewed.....135, 172, 206-207, 249-250, 295-298, 341-342, 376-378
DIOPHANTINE ANALYSIS (See Solutions and Problems).
EDITORIALS, 30, 60, 98, 134-135, 171-172, 205-206, 248-249, 293-294, 340-341 375-376.
GEOMETRY (See Solutions and Problems).
INFORMATION (See Queries).
MATHEMATICAL PAPERS—
Ackerman, Emma C., The Golden Section..... 260-264
Bell, A. H., The "Cattle Problem." By Archimedes, 251 B. C. 140-141
Dickson, Leonard E., A Quadratic Cremona Transformation Defined by a Conic 218-221
Some Fallacies of an Angle Trisector..... 71-72
The Inscription of Regular Polygons.....7-9, 38-40
Doolittle, Eric, Some Suggestions about Variation..... 109-111
The Construction of the Sun's Path..... 223-225
Ellwood, J. K., "The Irreducible Case"..... 69-70
Gridley, A. L., Diagram for the Laws of Falling Bodies..... 113-114
Gruber, M. A., A Trisector of Angles..... 112-113
Halsted, George Bruce, Non-Euclidean Geometry; Historical and Expository, 10, 42-43, 67-69, 108-109, 144-146, 181, 214, 256-257 309-313, 346-348.
Holden, Warren, An Attempt to Demonstrate the 11th Axiom of Playfair's Euclid..... 146-147
The Realization of Imaginary Points..... 182-184
Kunstadter, Ralph H., A Method of Integrating Certain Differential Equations of the First Order and N-th Degree..... 225-226
Loomis, E. S., Outline of Investigation for Asymptotes..... 185,204

Lyle, John N., II. Logical Deductions from the Hypothesis that the Angle Sum is less than two Right Angles..... 149-151
Postulate II. of Euclids Elements..... 266-267
Theoren 16 of Lobatschewsky's Theory of Parallels..... 70-71
True Propositions not Invalidated by Defective Proofs..... 111-112
Matz, F. P., Astonomical Determination of the Time of Thales.. 314-315
Cradle-Rocking by Elleptic Functions..... 147-148
Lagrange's Generalized Equations of Motion..... 63-67
The Rectification of the Cassinian Oval by means of Elliptic Functions.....221-223, 264-266, 355-357
Miller, G. A., Introduction to Substitution Groups, 142-144, 179-180 211-213, 257-260, 267-268, 304-309, 351-354.
Moore, E. H., A Note on Mean Values..... 303-304
Nicholson, J. W., A Proposition in Reference to Centre of Gravity, and its Demonstration..... 41
Philbrick, P. H., Isoperimetry without Curves or Calculus..... 5-6
Smith, David Eugene, Historical Survey of the Attempts at the Computation and Construction of π..... 348-351
Stone, Ormond, An Elementary Derivation of the Law of Gravitation as Applied to Planetary Motions..... 301-303
Zerr, G. B. M., Some Notes on the Theory of Probability..... 107-108
The Intrinsic Equation of a Curve in Polar Co-ordinates..... 215-217
MECHANICS (See Solutions and Problems).
MISCELLANEOUS (See Solutions and Problems).
PORTRAITS (See Biographies).
PROBLEMS, Unsolved,
No. 46—Arithmetic, 57; No. 53—Algebra, 74; No. 33—Diophantion, 189; No. 14—Miscellaneous, 198.
PROBLEMS (See Solutions).
PERIODICALS.....135-136, 172, 206-208, 249-251, 295-298, 341-342
QUERIES AND INFORMATION—
Answer to Trisection Problem, by Otto Clayton..... 247
Answer to Trisection Problem, by David E. Smith..... 247
Answer to "Reader's" Query, by J. N. Lyle..... 248
Answers to Queries in March number, Vol. I., by John N. Lyle. 372
A Postulate of the Hypothesis of the Fourth Dimension, by J.N. Lyle 336
A Query by J. H. Drummond..... 170
Are Lobatschewsky's Principles Applicable to Mechanics? by Warren Holden..... 95
A Reply to Prof. Whitaker, by H. W. Draughon..... 59
Arthur Cayley, by G. B. Halsted..... 96
Comments on Durege's Theory of Functions..... 339
Comments on Problem II, by W. F. Bradbury and L. E. Pratt.. 372

Death of Prof. Arthur Cayley, by F. P. Matz 28-29
Death of P. L. Tchebichef 29
Definition of a Fraction, by H. W. Draughon, H. C. Whitaker, and Chas. De Medici 337-338
Dr. Halsted's Latest Translation, by L. E. Dickson 58
Lambert's Reasons for Holding that the Parallel-Axiom Needs Proof, by J. N. Lyle 292-293
Note from Leonard E. Dickson 60
Note from Oscar Schmiedel 337,373
Note from W. E. Heal 337
Note on Helmholtz's Use of Terms "Surface" and "Space," by J. N. Lyle 338
Note on May Number of MONTHLY, by G. B. Halsted 205
Notes on the Demonstration of Euclid's Eleventh Axiom, by Warren Holden 247
Papers for the Mathematical Congress at Kazan 205
Prof. Scheffer's Query. Answer by F. P. Matz 96
Query as to Trisection of Angle with Rule and Compass, by W. E. Heal 171
Query by N. F. Davis 337
Query from Reader 337
Reply to Mr. Draughon, by H. C. Whitaker 169
Russian Science Notes 95
Space, by John N. Lyle 291-292
The International Mathematical Congress, by G. B. Halsted 169-170
The MONTHLY in Spain 247
"The Mysterious Formula," by M. C. Stevens 169
Those Astronomical Criticisms, by F. P. Matz 292
Trisection of Angle and Duplication of Cube, by E. J. Goodwin. 337
Wanted:—The Difference between Euclidean and Non-Euclidean Geometry, Etc 60

SOLUTIONS AND PROBLEMS.

ARITHMETIC.

Association, Borrowing from Building and Loan (unsolved) 74
Chain Suspended, to find sag, batter at ends, and tension 11
Date and Day of Week, Problem in Finding 226
Farm, A man bought, for $6000, and agreed to pay for it in four equal annual payments 354
Garden in form of △ with towers, to find length of ladder to reach top of each 227
Horse, at what price sell and wait to gain a certain per cent 315
Horse, to find per cent. gained in selling 74
Interest, to find yearly rate per cent under given conditions 115
Jars, how much wine in each after repeated pourings 44

Merchant using "false" weights, losing "bad debts," etc., to find rate per cent. of net profit 186
Money loaned at annual interest and partial payments made, to find amount due 315
Note, to find face of discounted at bank 270
Plums, how many to each competitor in a "scuffle" 115
Racing, A, B, and C 153
Room, cost to paper and dimensions given—to find cost of paper per roll 43
Shell, to find thickness of 45, 73, 114
Ship, to find part of purchase money paid by A and B 152
Sing-Sing and Tarry-Town, mittens, kitten-cats, etc., met between 12, 73
Stock, to find market price of 74
Traveling, to find when C starts to meet A and B at common point 74, 114
Walking and riding to city and back, time to ride both ways 269
Wine merchant's rate per cent. of profit on sales 10

ALGEBRA.

Algebraic equations, solved 46, 116
Equation of nth degree, $n<2$, transformed into number of equations wanting 2nd term 15
Equation, resolved into sum of two squares 75
Equation, to find algebraic relation of a and b in 359
Equation $x^5+5mx^3+5m^2x+n=0$, solved 359
Expression, value to be proved equal 0 (unsolved) 189
Find θ from $\cos\theta+\cos 3\theta+\cos 5\theta=0$ 271
Horses, 2 and a mule—to find cost and selling price 76
Interest, intervals of compounding infinitely small 317
Money loaned, required equal monthly payments in advance 317-318
Number, find number of 6 digits × first 6 natural numbers = same digits in rotation 13
Numbers, product of 2, each sum of 4 squares, expressed as sum of 4 squares in 48 ways 47
Prove that $(-1)(-1)=+1$ 272-274
Quadratics, equation solved by 117
Segment, area and radius given—to find height 75
Series, problem in 229
Table, ways 12 friends of MONTHLY arranged at 361
Traveling, time and distance from starting point of 4—"prize" problem 187
Triangle, bisectors of acute angles of rt. $\triangle$ given—to find triangle 154
Trigonometrical equation, solved 230
Voting, number of possible states of poll 155

GEOMETRY.

Circle cutting another in two fixed points, common chord passing thro' a fixed point 17
Circle, find radius of circle circumscribing 3 tangent circles of given radii 275

Conic, inscribed in △, focus moving along straight line, locus of other focus a conic circumscribing the △ 16
Field, horse tied to circle 10-A. so as to graze over 1-A.—find length of rope 48
Geometric proof of theorem of inscription of regular polygons..... 120
Parallelogram, line through points of intersection of lines from 2 points on opposite sides of—to opposite vertices, divides it in 2 equal parts 50, 77
Parallelopiped, find length of a diagonally inscribed into another..... 157
Polygon of 37 sides, lowest equation upon which depends inscription of 49
Quadrilateral, consecutive sides given and diagonals equal—to find them and the area..... 231
Rectangle, given 2 points and circumference with center O, to show that rectangle contained by OA and perpendicular from B on polar of A= rectangle by OB and perpendicular from A on polar of B..... 319
Semi-circle, rectangle of given and of maximum area inscribed in..... 119
Triangle, equilateral inscribed in circle, sum of squares of lines joining point in circumference to the vertices is constant 318
Triangle, proof of a geometrical problem in relation to..... 232
Triangle, lines joining centers of equilateral △s described on sides of a △, form an equilateral △ 121
Triangle, if bisectors of 2 angles equal, △ is isosceles 157, 189-191
Triangle, radius of circumference, in- and e-scribed circles of a △ given, to prove $r_1+r_2+r_3-r=4R$..... 156

CALCULUS.

Cardioid, area of circumscribing square 122-124
Catenary curve generates minimum area..... 193
Cube, figure described by revolving on an axis, and volume..... 276, 322
Curve, discussion of a given..... 324
"Curve of Pursuit"—hound and hare..... 233, 290
Differential equation, solved..... 320
Dome, to find volume of dome with given data..... 322-324
Earth, find at what latitude angle made by body falling to E, with perpendicular to surface, is greatest, and this angle 51-52
Field, B starts from center to circumference to catch A who runs around circumference, to find B's distance and time..... 80
Hawk in pursuit of hen, required path and distance to catch hen 82
Projection on diameter of semi-circle in given case equals radius of circle 159
Ship, maximum saving by sailing on arc of great circle instead of parallel of latitude and at what latitude..... 192
Stage, at what distance from to sit and see to best advantage 81
"The Devil on Two Sticks" problem..... 18-21
"The Cocked Hat" curve—the problem solved..... 362
Turn-table, distance man walks who crosses while it revolves twice.... 364

Merchant using "false" weights, losing "bad debts," etc., to find rate per cent. of net profit 186
Money loaned at annual interest and partial payments made, to find amount due 315
Note, to find face of discounted at bank 270
Plums, how many to each competitor in a "scuffle" 115
Racing, A, B, and C 153
Room, cost to paper and dimensions given—to find cost of paper per roll 43
Shell, to find thickness of 45, 73, 114
Ship, to find part of purchase money paid by A and B 152
Sing-Sing and Tarry-Town, mittens, kitten-cats, etc., met between 12, 73
Stock, to find market price of 74
Traveling, to find when C starts to meet A and B at common point 74, 114
Walking and riding to city and back, time to ride both ways 269
Wine merchant's rate per cent. of profit on sales 10

ALGEBRA.

Algebraic equations, solved 46, 116
Equation of nth degree, $n<2$, transformed into number of equations wanting 2nd term 15
Equation, resolved into sum of two squares 75
Equation, to find algebraic relation of a and b in 359
Equation $x^5+5mx^3+5m^2x+n=0$, solved 359
Expression, value to be proved equal 0 (unsolved) 189
Find θ from $\cos\theta+\cos 3\theta+\cos 5\theta=0$ 271
Horses, 2 and a mule—to find cost and selling price 76
Interest, intervals of compounding infinitely small 317
Money loaned, required equal monthly payments in advance 317-318
Number, find number of 6 digits × first 6 natural numbers = same digits in rotation 13
Numbers, product of 2, each sum of 4 squares, expressed as sum of 4 squares in 48 ways 47
Prove that $(-1)(-1)=+1$ 272-274
Quadratics, equation solved by 117
Segment, area and radius given—to find height 75
Series, problem in 229
Table, ways 12 friends of MONTHLY arranged at 361
Traveling, time and distance from starting point of 4—"prize" problem 187
Triangle, bisectors of acute angles of rt. $\triangle$ given—to find triangle 154
Trigonometrical equation, solved 230
Voting, number of possible states of poll 155

GEOMETRY.

Circle cutting another in two fixed points, common chord passing thro' a fixed point 17
Circle, find radius of circle circumscribing 3 tangent circles of given radii 275

Conic, inscribed in △, focus moving along straight line, locus of other focus a conic circumscribing the △ 16
Field, horse tied to circle 10-A. so as to graze over 1-A.—find length of rope 48
Geometric proof of theorem of inscription of regular polygons..... 120
Parallelogram, line through points of intersection of lines from 2 points on opposite sides of—to opposite vertices, divides it in 2 equal parts 50, 77
Parallelopiped, find length of a diagonally inscribed into another..... 157
Polygon of 37 sides, lowest equation upon which depends inscription of 49
Quadrilateral, consecutive sides given and diagonals equal—to find them and the area..... 231
Rectangle, given 2 points and circumference with center O, to show that rectangle contained by OA and perpendicular from B on polar of A= rectangle by OB and perpendicular from A on polar of B..... 319
Semi-circle, rectangle of given and of maximum area inscribed in..... 119
Triangle, equilateral inscribed in circle, sum of squares of lines joining point in circumference to the vertices is constant 318
Triangle, proof of a geometrical problem in relation to..... 232
Triangle, lines joining centers of equilateral △s described on sides of a △, form an equilateral △ 121
Triangle, if bisectors of 2 angles equal, △ is isosceles 157, 189-191
Triangle, radius of circumference, in- and e-scribed circles of a △ given, to prove $r_1+r_2+r_3-r=4R$..... 156

CALCULUS.

Cardioid, area of circumscribing square 122-124
Catenary curve generates minimum area..... 193
Cube, figure described by revolving on an axis, and volume..... 276, 322
Curve, discussion of a given..... 324
"Curve of Pursuit"—hound and hare..... 233, 290
Differential equation, solved... 320
Dome, to find volume of dome with given data..... 322-324
Earth, find at what latitude angle made by body falling to E, with perpendicular to surface, is greatest, and this angle 51-52
Field, B starts from center to circumference to catch A who runs around circumference, to find B's distance and time..... 80
Hawk in pursuit of hen, required path and distance to catch hen 82
Projection on diameter of semi-circle in given case equals radius of circle 159
Ship, maximum saving by sailing on arc of great circle instead of parallel of latitude and at what latitude..... 192
Stage, at what distance from to sit and see to best advantage 81
"The Devil on Two Sticks" problem..... 18-21
"The Cocked Hat" curve—the problem solved..... 362
Turn-table, distance man walks who crosses while it revolves twice.... 364

Vessel, rate at which depth of water running into right conic frustum is increasing 233
Volume in a calculus problem determined 364
Wall, to find circumference of when 2 mules tied to outside and inside of same, and lengths of ropes ½ of circumference, together graze 1 *A* .. 277

MECHANICS.

Anchor-ring, moment of inertia about axis thro' center of direct circle, and perpendicular to a plane 22, 53
Balls, number of given mass and velocity in a confined space, into which other balls are introduced; after a number of collisions when average kinetic energy of each is the same, to find its value in centm.—gram.—system 280
Cord, condition that a suspended hang in arc of a circle 194
Density of strings, law of heap at edge of table that equal masses pass over in equal units of time 126, 161
Deviation, eastward of bodies falling from great height..... 54, 83
Equilibrium, a point of a harmonical mean in the given problem 236
Iron bar, determine pressure upon floor and wall when leaning against at given angles 125
Moon, initial velocity of old woman tossed 90 times as high..... 162
Paraboloid, at what point of surface below intersection with a cylinder a heavy particle will rest..... 127
Perfectly elastic, but perfectly rough mass *M* and radius *R*..... 366
Prismatic bar which snaps, to find result, angular velocity, and locus of parts at any time 195
Rough circumference of a circle, *P* is the lowest point 366
Sphere, ratio of electrical densities when initial velocity increased 279
Sphere, when slide, roll, etc., on rough inclined plane..... 237
Train, stopped by setting brakes—find velocity..... 238
Triangle, course after reflection of body projected from angle of triangle 326
Wheel and axle, mechanical problem relating to..... 195
Wire, motion of movable wire in case of a finite moving and a perpendicular infinite, each carrying currents of electricity..... 326

DIOPHANTINE ANALYSIS.

Arithmetical progression, find 9 positive integral numbers in, the sum of whose squares = □ ; and 9 integral square numbers whose sum is a square number 129, 163
Decompose into sum of two squares $17^3.73^5$..... 85
Diophantus' epitaph 284, 329
Find 2 integral numbers, whose sum, difference, and difference of squares shall be a square, cube, and fourth power..... 128
Find 3 positive integral numbers whose sum is a cube, and, the sum of any two less the third is a cube..... 86

Find 3 positive integral numbers such that product of first and sum of others = □ and the sum of their cubes = □ 196
Formula for 5 integers sum of whose cubes is a cube 329
Fraction, square fraction the arithmetical difference of terms a cube, and a cubic fraction arithmetical sum of whose terms = □ 239
Impossible to find 2 positive whole numbers such that each, and also sum and difference, less 1=squares 25
Numbers, 3 such that cube af any one+sum of squares of other two=a square 24
Parallelopiped, to find values of the 7 linear measurements 329
Prime factors, decompose in the number, 549755813889 369
Prove that $A+B+1$ is a square in the given problem 337
Sixth powers, 3 different whose sum is a square (unsolved) 198
Solve generally: Sum of the cubes of n consecutive numbers = □ 197
"Sum of squares equal a square," equation for 285
Sum of 2 fourth powers, decompose product 97.675.257 into 331
Sum of 2 squares, decompose into the product $5\times13\times61$ 164
Triangles, how many scalene of integral sides with altitude 12, how many isosceles 368

AVERAGE AND PROBABILITY.

Annuity, what it is worth 130
Average area of all right triangles having a constant hypotenuse 282, 327
Average area of △ formed by 3 perpendiculars from the sides of the △. 243
Average volume common to cube and rectangular solid 90
Circle, average area of circle which is locus of middle points of chords thro' random point in surface 166, 241
Field, probability that boy who runs from corner in random direction will be in field at end of 1 minute 200
Melons, probability of taking a good one from patch 88, 165
Note on Problem 26 370
Polygon, chance that one of two n sides, thrown at random upon ruled plane will fall across a line 26-28
Probability that distance of 2 random points in a convex area excels a gived limit 281
Projectile, chance of its falling within a circular field 88, 166
Roots, mean values of a given quadratic 87
Surface, mean value of sum of distances of vertices of sides from any vertex of another on which it is thrown 199
Testimony, probability of concurrent, of A and B 131
Triangles, average area of all that can be drawn perpendicular—sided to given scalene △ 242
Votes, probability that last count is correct 201

MISCELLANEOUS.

Apples, to find number of boys who will eat ("Iago's" problem) 333

Center of gravity of plane surface, when sum of distances of point from all the other points is a minimum 324
Chronometer runs down and is set again after a star passed my meridian, to find when it was set, my latitude and star's declension given..... 204, 244
Confocal conics, show that system is self-orthogonal..... 203
County-seat, to determine most eligible point in county 289
Cylinders, compute lengths of curves of intersection of two surfaces, when axes of 2 intersect at right angles..... 168, 286
Dog-Star and Sun, when rise together..... 204, 245, 286
Helix traced on clyl., measures of curvature and tortuosity of a curve is constant 93
Mirrors, walls, etc., covered with and candle placed within, to find formula to express all the images..... 333
Moon's disc, illuminated area when $\frac{3}{4}$ through first quarter 133, 167
Paper-weight, no of spectra formed in a glass one in form of a regular icosahedron (unsolved)..... 57
Ship's log, cut from what kind of wood to float with *c.g* at water's surface 287
Soap-bubble, find thickness of film if just floats in air..... 56
Spherical shrapnel-shell explodes curve bounding minimum surface on the earth upon which fragments fall..... 203
Time of Thales, determine from data of problem 288